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SPECIFICATION FOR TRANSFORMERS FOR HIGH VOLTAGE LUMINOUS DISCHARGE TUBES

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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March 1963

Indian Standard

SPECIFICATION FOR TRANSFORMERS FOR HIGH VOLTAGE LUMINOUS DISCHARGE TUBES

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SPECIFICATION FOR TRANSFORMERS FOR HIGH VOLTAGE LUMINOUS DISCHARGE TUBES

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 4 February 1963, after the draft finalized by the Electric Lamps and Accessories Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 High voltage luminous discharge tubes, also commonly known as neon sign tubes, are well adapted for sign lighting, for publicity and for decorative purposes owing to their bright colours and the fact that these tubes lend themselves readily to the forming of letters and figures. Like all gaseous discharge lamps, these high voltage luminous discharge tubes require a higher voltage to start the discharge than the voltage required under running conditions. The important auxiliary is, therefore, the step-up transformer of high leakage reactance type in which the secondary voltage falls rapidly as the current drain is increased. This feature provides the higher voltage required to start the lamp and later tends to make the discharge circuit stable once the discharge is started.

0.3 The essential characteristics of this type of transformers are:

a) large voltage transformation ratio to provide secondary open circuit voltage up to 15 kV RMS between terminals with the primary voltage not exceeding 250 V,

b) low output current, and

c) high leakage reactance normally provided by a magnetic shunt to act as a current regulator.

0.4 This standard has been prepared with a view to specify the requirements and methods of test for such transformers to guide the manufacturing of these units which is mostly in the hands of small scale industries. The importance of safety requirements are also borne in mind while preparing this standard.

0.5 Taking into consideration the views of producers, consumers and testing authorities, the Sectional Committee responsible for the preparation of this standard felt that it should be related to the manufacturing and trade practices followed in the country in this field. Furthermore, due weightage had to be given to the need for international co-ordination among standards prevailing in different countries of the world in this field. These considerations led the Sectional Committee to derive assistance from the following standards:

B.S. 326 : 1941 ELECTRICAL PERFORMANCE OF HIGH TENSION TRANSFORMERS FOR X-RAY PURPOSES. British Standards Institution.

B.S. 559 : 1955 ELECTRIC SIGNS AND HIGH VOLTAGE LUMINOUS DISCHARGE TUBE INSTALLATIONS. British Standards Institution.

ASA No. C 33.4-1958 SPECIALITY TRANSFORMERS. American Standards Association.

NEMA PUB. No. ST 1-1955 SPECIALITY TRANSFORMERS. National Electrical Manufacturers' Association USA.

0.6 This standard is one of the series of Indian Standards relating to lamp and lamp accessories and the other standards so far published in this series are:

IS : 418-1963 SPECIFICATION FOR TUNGSTEN FILAMENT GENERAL SERVICE ELECTRIC LAMPS (SECOND REVISION)

*IS : 897-1957 SPECIFICATION FOR TUNGSTEN FILAMENT ELECTRIC LAMPS FOR RAILWAY ROLLING STOCK

IS : 1569-1963 SPECIFICATION FOR CAPACITORS FOR ELECTRIC DISCHARGE LAMPS (FLUORESCENT AND MERCURY VAPOUR)

IS : 1901-1961 SPECIFICATION FOR VISUAL INDICATOR LAMPS

IS : 2183-1963 SCHEDULE FOR HIGH PRESSURE MERCURY VAPOUR LAMPS

IS : 2261-1963 SPECIFICATION FOR LAMPS FOR FLASHLIGHT

0.7 Wherever a reference to any Indian Standard appears in this specification, it shall be taken as a reference to the latest version of the standard.

0.8 Metric system has been adopted in India and all quantities and dimensions appearing in this standard have been given in this system only.

0.9 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960 Rules for Rounding Off Numerical Values (*Revised*). The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

0.10 This standard is intended chiefly to cover the technical provisions relating to transformers for high voltage luminous discharge tubes, and it does not include all the necessary provisions of a contract.

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*Since revised.

1. SCOPE

1.1 This specification covers transformers, having a secondary voltage not exceeding 15 kV RMS between terminals and/or 7·5 kV RMS to earth on open circuit and a primary voltage not exceeding 250 V at a frequency of 50 c/s, used with high voltage luminous discharge tubes which may be employed for sign lighting, for publicity or for decorative purposes, either for indoor use or for outdoor use (when suitably protected against rain).

2. TERMINOLOGY

2.0 For the purposes of this standard, the following definitions shall apply.

2.1 Luminous Discharge Tube — A tube or device which is constructed of translucent material, is hermetically sealed and is designed for the emission of light arising from the passage of an electric current through gas or vapour contained within it. The tube may be with or without a flourescent coating.

2.2 Luminous Discharge Tube Transformer—A transformer having a high secondary voltage with low current drain and high reactance to limit the secondary short-circuit current.

2.3 Primary Terminals of a Transformer — Terminals providing means of connection to the input winding of the transformer.

2.4 Secondary Terminals of a Transformer — Terminals providing means of connection to the output winding or windings of the transformer.

2.5 High Voltage — Voltage normally exceeding 650 V but not exceeding 33 kV.

2.6 Ratings of Transformer

2.6.1 *Input Rating at Secondary Short-Circuit*—The input volt-amperes at rated primary voltage with the secondary short-circuited.

2.6.2 *Secondary Short-Cricuit Current Rating*—The current in the secondary windings when the primary winding is connected to a circuit of rated primary voltage and frequency, and when the secondary terminals are short-circuited.

2.7 Rated Voltages — The voltages marked on the rating plate.

2.7.1 *Rated Primary Voltage*—The voltage to be applied to the primary (input) terminals of the transformer.

2.7.2 *Rated Secondary Voltage*—The voltage developed at the secondary (output) terminals of the transformer *at no load* when rated primary voltage of sine-wave form is applied to the primary terminals.

2.8 Type Tests—Test carried out to prove conformity with the requirements of this specificatian. These are intended to prove the general qualities and design of a given type of transformer.

2.9 Routine Tests—Tests carried out on each transformer to check essential requirements which are likely to vary during production.

2.10 Ambient Temperature—The temperature of the surrounding medium.

3. MATERIALS

3.1 General—Transformers shall be constructed from the most suitable material free from flaws and defects and suitable for tropical use. Any material used in the construction shall not be readily ignitable. No hygroscopic material shall be used unless it has been previously rendered moisture-proof.

3.2 Winding Wires—Wires used in the winding of transformers shall be of adequate current carrying capacity and shall conform to the relevant Indian Standards.

3.3 Laminations of Core Assembly—Laminations shall be made from electrical steel sheets conforming to *IS: 648-1962 Specification for Steel Sheets for Magnetic Circuits of Power Electrical Apparatus (Non-Oriented Steel) (*Revised*).

3.3.1 Laminations shall be of uniform dimensions and electrically insulated from one another, at least on one side, by a thin coat of insulating film or material (oxide film is included for this purpose).

3.3.2 The laminations shall be flat and without burrs or sharp edges.

3.4 Insulating and Impregnating Materials—The insulating and impregnating materials suitable for each particular application shall be used (*see also* *IS : 350-1952 to IS : 353-1952 Specifications for Insulating Varnishes and IS : 1271-1958 Classification of Insulating Materials for Electrical Machinery and Apparatus in Relation to their Thermal Stability in Service).

3.5 Sealing Compound—The compound, used for sealing the transformers, shall have the following characteristics:

a) It shall not crack when maintained at a temperature of 0°C for 24 hours,
b) It shall not absorb moisture, and
c) It shall not flow when kept at a temperature of 120°C for 24 hours and held in a position most conducive to possible running down.

3.6 All other materials used shall conform to relevant Indian Standards, wherever available.

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*Since revised.

4. RATING

4.1 Rated Primary Voltage — The rated primary voltage shall not exceed 250 V, the preferred voltages being 230 V and 240 V, at a frequency of 50 c/s.

4.2 Rated Secondary Voltage — The rated secondary voltage shall be chosen from the values specified in col 1 of Table I.

TABLE I RATING OF TRANSFORMERS

SECONDARY OPEN-CIRCUIT VOLTAGE RATING	SECONDARY SHORT-CIRCUIT CURRENT RATING	INPUT RATING AT SECONDARY SHORT-CIRCUIT
Volts	Milliamperes	Volt-amperes
2 000	18	50
3 000	18	75
	30	100
	60	180
4 000	18	90
	30	140
	60	240
5 000	18	100
	30	160
	60	300
	120	600
6 000	18	130
	30	180
	60	360
	120	720
7 500	18	150
	30	225
	60	450
	120	900
9 000	18	180
	30	270
	60	540
	120	1 080
12 000	18	225
	30	360
	60	720
15 000	18	270
	30	450
	60	900

4.3 Input Rating at Secondary Short-Circuit and Secondary Short-Circuit Current Rating — The input rating at secondary short-circuit and the corresponding secondary short-circuit current rating for a specified open-circuit voltage at secondary terminals shall be as specified in Table I.

5. CONSTRUCTION

5.1 General—The transformer shall be so designed and constructed as to be capable of providing continuously the necessary tube running current, which is approximately 80 percent of the secondary short-circuit current, with the primary connected to rated primary voltage and frequency, without the temperature-rise exceeding the limits specified in this standard (*see* 7.7).

5.2 Enclosures—Transformers of open-circuit secondary voltage exceeding 5 kV between terminals (or 2·5 kV to earth) and secondary short-circuit current exceeding 18 mA shall be of enclosed type and other transformers may be of either unenclosed core and coil or the enclosed type.

5.2.1 Enclosed transformers shall be provided with enclosures of non-combustible, moisture-resistant material, protected against corrosion. The enclosures shall contain all uninsulated live metal parts except that primary or secondary leads or terminals may extend outside of the enclosure.

5.2.2 The enclosure shall be formed from sheet steel of not less than 0·70 mm in thickness. An enclosure of material other than sheet steel shall provide equivalent mechanical strength and rigidity.

NOTE—Transformers for outdoor use are designed for application within the structure of outdoor signs. Such transformers are not applicable in indoors unless ventilation is adequate to maintain an ambient temperature not greater than 40°C under maximum operating conditions.

5.3 Winding—The transformer shall be double wound with windings insulated with suitable materials.

5.4 Clamping—The transformers shall be suitably clamped to hold the stampings tightly together in order to prevent vibration and to provide a simple means of mounting the complete transformer.

5.5 Terminations—The transformers shall be provided with wiring terminals (other than set-screw form), for the connection of the primary circuit conductors. Provision shall be made for secondary circuit connections by means of wiring terminals mounted in/or through suitable bushings preferably made of porcelain or similar material.

5.5.1 Transformers rated higher than 225 VA shall have secondary high voltage terminals at opposite ends.

5.5.2 Leads shall not enter the enclosure through a removable cover if connections are to be made in the field.

5.6 Earthing – Transformers of centre-earthed or one-end-earthed type shall be provided with an earthing terminal which shall be electrically connected to the core. Enclosed type transformers shall have their enclosures connected to the core.

5.7 Prevention of Abrasion – Where a cable is taken into the enclosure of the transformer, the entry shall be bushed or finished as to prevent abrasion of the cables. In addition the entry shall be so arranged as to preclude the entry of moisture.

5.8 Finish

5.8.1 All exposed metal parts such as end-shells, brackets and hardware parts shall be plated, painted or otherwise protected to prevent corrosion.

5.8.2 Exposed edge of laminations shall be suitably treated to prevent corrosion.

5.8.3 Unless otherwise specified, all materials liable for deterioration in moist or other corrosive atmosphere shall be given a suitable protective finish.

5.9 Workmanship—All parts shall be manufactured in a thoroughly workmanlike manner in accordance with the best engineering practice.

6. MARKING

6.1 Transformer for luminous discharge tubes shall be clearly and indelibly marked with the following minimum information in such a manner that the marking is readily visible after the transformer is installed:

a) Manufacturer's name or trade-mark,
b) Type designation,
c) Rated primary voltage (RMS),
d) Open circuit secondary voltage (RMS),
e) Secondary short circuit current,
f) Input volt-amperes (at secondary short circuit),
g) Frequency,
h) Type of secondary earthing (mid-point or one end), and
j) Country of manufacture.

6.2 BIS Certification Marking

The product may also be marked with Standard Mark.

6.2.1 The use of the Standard Mark is governed by the provisions of the Bureau of Indian Standards Act, 1986 and the Rules and Regulations made thereunder. The details of conditions under which the licence for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

7. TESTS

7.1 General Conditions for Testing

7.1.1 Unless otherwise specified, the tests shall be carried out at the prevailing ambient temperature.

7.1.2 Rated primary voltage at the rated frequency as specified shall be applied to the input terminals of the transformer.

7.2 Classification of Tests

7.2.1 Type Tests—The following tests shall constitute type tests:

a) Test for High Voltage (**7.3**),
b) Test for Insulation Resistance (Dry) (**7.4**),
c) Test for Open-Circuit Secondary Voltage (**7.5**),
d) Test for Secondary Short-Circuit Current and Input Volt-Amperes (**7.6**),
e) Test for Temperature-Rise (**7.7**),
f) Test for Induced Voltage (**7.8**), and
g) Test for Moisture Resistance (**7.9**).

7.2.1.1 *Number of samples*—The tests specified in **7.2.1** shall be carried out on 5 samples, preferably selected at random from a regular production lot in the sequence given therein. If failure occurs in one or more tests, the testing authority, at its discretion, may call for fresh samples not exceeding twice the original number and repeat the tests. The type shall be considered conforming to this standard if no failure occurs in the repeat tests.

7.2.2 *Routine Tests*—The following shall constitute routine tests:

a) Test for High Voltage (**7.3**),
b) Test for Insulation Resistance (Dry) (**7.4**),
c) Test for Open-Circuit Secondary Voltage (**7.5**), and
d) Test for Secondary Short-Circuit Current and Input Volt-Amperes (**7.6**).

7.3 Test for High Voltage—The transformer shall be capable of withstanding the application of an AC voltage of 2 000 V RMS at the rated frequency for a period of one minute applied between the primary winding and the core end case.

All other circuits and metal parts shall be earthed during this test.

7.4 Test for Insulation Resistance (Dry)—The insulation resistance (dry) shall be measured between the primary winding and the core of the transformers by applying 500 DC for one minute.

7.4.1 The insulation resistance thus measured shall be not less than 20 megohms.

7.5 Test for Open-Circuit Secondary Voltage—With the rated primary voltage at the rated frequency applied to the primary terminals, the open-circuit secondary voltage shall be measured with an electrostatic or other suitable meter.

7.5.1 The input voltage shall not have distortion more than one percent.

7.5.2 The open-circuit secondary voltage (RMS) of a transformer shall not differ by more than ± 10 percent of the rated value.

7.5.2.1 However, in the case of transformers of 15 kV between secondary terminals or 7·5 kV to earth, the open-circuit secondary voltage shall not exceed 16 kV between terminals or 8 kV to earth.

7.6 Test for Secondary Short-Circuit Current and Input Volt-Amperes

7.6.1 The secondary terminals of the transformer with centre-earthed secondary windings shall be short-circuited through a milliammeter; earth-ended transformers having one end connected to the core and thus to the earthing terminal shall have the secondary winding connected to the earthing terminal through a milliammeter. The primary terminals shall be connected to the rated primary voltage and frequency through suitable voltmeter and ammeter to measure the input of the transformer.

7.6.2 The secondary short-circuit current shall not differ by more than ± 5 percent from the rated value.

7.6.3 The input volt-amperes shall not differ by more than ± 5 percent from the rated value.

7.7 Test for Temperature-Rise

7.7.0 This test shall be carried out at an ambient temperature not exceeding 40°C.

7.7.1 The secondary terminals of the transformers with centre-tapped secondary windings shall be connected together as short-circuit; earth-ended transformers having one end connected to the core shall have the secondary windings connected to the earth terminal.

7.7.2 The transformer shall then be energized at the rated primary voltage at rated frequency.

7.7.3 The temperature-rise of the transformer windings shall be measured by the change of resistance method (*see* Appendix A) after the temperature has become constant.

7.7.3.1 The temperature shall be considered constant when 3 successive measurements of resistance of the winding taken at intervals of 10 minutes, indicate no change.

7.7.3.2 All hot resistance readings shall be completed within three minutes after the input supply is discontinued.

7.7.4 The temperature-rise thus measured, shall not exceed the following limits:

Class of Insulation	*Temperature-Rise (in deg C)*
*A	55
*E	70
*B	80

7.7.4.1 The class of insulation used shall be specified in the test report.

7.7.5 The transformer shall then be subjected to the test for high voltage in accordance with **7.3**. There shall be no arcing, flash-over or breakdown.

7.8 Test for Induced Voltage

7.8.1 Keeping all other windings on open circuit, an alternating voltage of as nearly as possible sine-wave form, at any convenient frequency suitably increased above the rated frequency (approximately in the ratio of test voltage to rated voltage of the winding between the terminals used), to avoid excessive exciting current during the test shall be applied to the primary terminals. The value of the test voltage shall be 1·5 times the rated primary voltage and the RMS value of the test voltage shall be measured directly by a suitable voltmeter. The standard duration of test shall be 60 seconds for any test frequency up to and including twice the rated frequency. Where the test frequency exceeds twice the rated frequency the duration of the test shall be equal to:

$$\frac{60 \times 2 \times \text{rated frequency}}{\text{test frequency}} \text{ seconds}$$

but in no case the duration of the test shall be less than 30 seconds. At the end of the test, the test voltage shall be rapidly decreased to normal rated voltage before switching off.

7.8.2 The transformer shall be capable of withstanding the induced voltage without arcing or breakdown.

7.9 Test for Moisture Resistance

7.9.1 *Preconditioning*—The transformer shall be subjected to a damp treatment for a period of 16 hours by keeping it in a humidity chamber in

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**See* IS : 1271-1958 Classification of Insulating Materials for Electrical Machinery and Apparatus in Relation to Their Thermal Stability in Service.

which the relative humidity is not less than 95 percent at a temperature of 60° ± 2°C.

7.9.2 After the preconditioning the insulation resistance shall be measured not later than 10 minutes after its removal from the humidity chamber and after any visible droplets of water or moisture have been wiped with a blotter or cotton cloth, in accordance with **7.4**.

7.9.2.1 The insulation resistance shall not be less than 2 megohms.

APPENDIX A

(*Clause* 7.7.3)

DETERMINATION OF TEMPERATURE-RISE BY INCREASE OF RESISTANCE METHOD

A-1. This method determines the average temperature of winding by measuring the increase of resistance produced by heating, assuming the conductors to be of pure copper as distinct from temperature at the surface or an isolated point.

A-2. The temperature of the winding as measured by thermometer or thermocouple before beginning the test shall not differ from that of the surrounding atmosphere or medium. The initial resistance of the winding shall also be measured without causing appreciable heating.

A-3. The resistance of the conductor or winding shall be measured when hot and temperature-rise shall be calculated from the following formula:

$$\frac{R_2}{R_1} = \frac{1 + \alpha T_1}{1 + \alpha T_2}$$

where

R_1 = resistance in ohms at temperature T_1 °C

R_2 = hot resistance in ohms at temperature T_2 °C,

T_1 = initial temperature in degrees Centigrade,

T_2 = final temperature in degrees Centigrade, and

α = temperature co-efficient of the copper equivalent to $\frac{1}{234{\cdot}5}$

From this formula the 'hot temperature' T_2 may be expressed as follows:

$$T_2 = \frac{R_2}{R_1} \times (234{\cdot}5 + T_1) - 234{\cdot}5$$

A-4. An approximate method of determining the temperature-rise is to calculate one Centigrade degree for each 0·4 percent increase in resistance.

A-5. This method is applicable to all windings having a resistance of not less than 0·01 ohm at the ambient temperature of the test room. For windings having a resistance of less than 0·01 ohm this method would only yield inaccurate results. In such cases surface temperature can be measured either by means of a thermometer or a thermocouple.

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